Welcome back. I hope you survived all of that terminology and have arrived closing in on the end of this lecture not completely exhausted and ready to do one little wrap-up. I got two issues to address in the last part of it and one of it is the pronunciation of A-P-O-P-T-O-S-I-S. The word apoptosis, apoptosis. There is an ongoing controversy. When I first encountered it, the author insisted that this word didn't have the first T pronounced like pterodactyl, isn't pterodactyl but these days people do seem to pronounce the T and some of them pronounce it apoptosis and some of them apoptosis. Apoptosis, and that is again three different possibilities and so how do you really pronounce it? You pronounce it the way the head of your lab pronounces it or your teacher or whatever, because as far as I can tell, there isn't a definitive answer. But at the same time, I want you to realize that there may not be a definitive answer but there is a big difference between apoptosis and necrosis. That is, apoptosis is a controlled way of killing off a cell and disposing of the contents. In necrosis, you have a cell that basically swells, breaks open, spills its guts and causes a lot of inflammation. Not good. So that in most cases when we're turning over cells, whether they're excess immune cells or infected cells or malignant cells, we try to do it by apoptosis which will then break it up in a controlled way. In the next part, we can see that here is a cell being taken apart by apoptosis. You can see that the nucleus shrinks, the cell shrinks, it blebs into little bite size packets and that makes things easier for the macrophages to clean up and it also prevents it from spilling cytoplasm all over the place and producing inflammation. To me it's like the difference between implode a building and blowing it up. If you implode a building, you take it down in a very controlled way that minimizes damage and minimizes the spread of debris. You blow things up and heaven only knows what kind of a mess you make and how many people you hurt. So, this is going to be a very important process in the rest of the things that we do in this course because in many cases, we will be eliminating a lot of cells and this is the way they're going to go. Now, the next issue I want to look at is the phylogenetic evolutionary sources of the immune system. The adaptive immune system is found only in the vertebrates, that is organisms that have a backbone, that have bones, us mammals, birds, frogs, fish, all of these have some form of adaptive immune system. The phylum we're in however is called the Phylum Chordata. So, here is a picture of one of the very first, we think, types of chordates. Looks a lot like a tadpole, doesn't it? In fact, it really is structured a lot like a tadpole. It has a nerve cord down the back, it has something called a notochord, a cartilaginous rod that runs through it. Unlike fish, frogs, mammals, it does not have an adaptive immune system, it does of course have an innate immune system because nothing can get by without some sort of protection but the critter that we seem to be descended from did not have this form of protection. Now, it was, however, a filter feeder and bottom feeder and muck eater. So you can see that it lived the kind of life were a little extra protection would have been a good thing and that is also probably true of the early fish. So, what we see in the early fish or the beginnings of the adaptive immune system generally concentrated around the gut where they're exposed to the worst there is. As we look at the evolution of increasingly complex fish and eventually tetrapods, things with four legs, we see more and more elements of the immune system. The thymus, other primary organs. It's not until we get to what are called the egg-laying creatures that we start to see a full immune system in all its glory of B-cells, T-cells, follicular development. So, in the mammals and the reptiles and the birds, we have the full beauty of the adaptive immune system. I think, not coincidentally, these are among some of the largest creatures on the planet. Takes a lot of protection if you're going to grow to be as big as an elephant or a whale or even a crocodile. Finally, I would suggest that since all of these creatures had this adaptive immune system, the dinosaurs must have had it, too. So, again, I think we have the adaptive immune system to thank in part for some of the most interesting things that have ever been on land. Next, we're going to go into the innate system and see how all of this is supported and then we'll start in on the specifics of the adaptive in lecture four.